

# Plant Document Analysis

Generated on: 2025-12-12 11:33:49

End of Engineering Analysis Report

## ENGINEERING SPECIFICATION ANALYSIS

### *Focus Area: Nozzle Load Analysis*

*Generated on December 12, 2025*

#### Accepted Specifications for Evaluation of Nozzle Load Analysis

- Codes / standards called out that govern pressure-retaining equipment and piping (relevant to nozzle design/reinforcement and allowable stresses):
  - ASME Section VIII Div.1 (vessels and pressure parts) — referenced for vessel mechanical design.
  - API 650 (atmospheric storage tanks) and API 653 (tank modification) — tank nozzle context.
  - ANSI B31.3 for process piping — piping design standard.
  - IS 1893 (seismic) — seismic design compliance required.
- Piping stress / nozzle-analysis software specified:
  - Caesar, NOZZLEPRO, CAEPIPE listed for piping stress / nozzle calculations.
- Units / UOM conventions (relevant for presenting loads and inputs to analysis):
  - Length: m / mm; Force: N; Moment: Nm; Pressure: kg/cm<sup>2</sup>g (and kg/cm<sup>2</sup>a for absolute); Temperature: °C; Mass: t / kg; Flow units defined. (Document defines project UOM conventions.)
  - Design pressure/temperature methodology and margins (affects internal pressure load used for nozzle design):
    - Table of margins to be added to maximum operating pressure for design pressure (explicit values):
      - Vacuum to 1.8 kg/cm<sup>2</sup> g → design typically 3.5 kg/cm<sup>2</sup> g (50 psig).
      - to 17.6 kg/cm<sup>2</sup> g → design = Max Operating Pressure + 1.8 kg/cm<sup>2</sup> g (25 psig).
      - to 35.2 kg/cm<sup>2</sup> g → design = Max Operating Pressure × 1.1.

- to 70.3 kg/cm<sup>2</sup> g → design = Max Operating Pressure + 3.5 kg/cm<sup>2</sup> g (50 psig).
- Over 70.3 kg/cm<sup>2</sup> g → design = Max Operating Pressure × 1.05.
  - Minimum nozzle / connection requirements on pressure vessels (affects nozzle reinforcement and minimum sizes):
    - On pressure vessels, minimum nozzle size shall be 1½".
    - Connections on pressure vessels shall be flanged unless welded construction preferred.
    - Separate 2" nozzle shall be provided as steam-out or utility connection.
    - Vessel vent/drain nozzle sizing table (explicit minimum vent/drain nozzle sizes by vessel volume):
      - Vent: up to 6 m<sup>3</sup> → 1½"; above 6 m<sup>3</sup> → 2".
      - Drain: up to 6 m<sup>3</sup> → 1½"; 6.1–15 m<sup>3</sup> → 2"; above 15 m<sup>3</sup> → 3".
        - Heat exchanger nozzles and requirements (relevant to exchanger nozzle loads / reinforcement):
          - Vent/drain on exchangers: 1½" nozzle with blind flange if not vented from process nozzle.
          - Drain valve of adequate size (3" minimum) with spectacle blind on cooling water supply line downstream of isolation valve for back-flushing.
          - Multi-purpose connections: 50 NB on all process nozzles.
          - Hydrotight / utility connections: 3/4" utility connection on inlet/outlet nozzles of tube & shell sides for hydrotight.
          - Thermowells: inlet and outlet on both shell & tube side (for cooling water service thermowell only on outlet).
          - Cooling water exchangers: extra nozzle for chemical cleaning where required.
          - Heat exchanger / exchanger tube specifications and fouling/velocity values (useful for nozzle flow-induced load cases):
            - Tube-side minimum velocities (examples): cooling water 1.3 m/s at normal flow; residues/heavy oil 1 m/s turndown; slurry oil 1.5–2.3 m/s.
  - Equipment design temperature and MDMT rules (affect thermal loads for nozzle analysis):
    - Design Temperature: where not specified, 28 °C plus coincidental temperature at design pressure; special rules for >343 °C etc.
    - MDMT: most stringent of minimum ambient minus 5.6 °C, minimum operating minus 5.6 °C, and minimum equipment temperature from depressurising criteria.
    - Seismic and wind environmental loading data (external loads for nozzle/attachment design):
      - Wind (onshore): 50 m/s 3-second gust at 10 m elevation (50-yr return).

- Offshore operational wind: 15 m/s mean hourly at 10 m (5■yr); extreme survival 33 m/s mean hourly at 10 m (500■yr).
- Seismic: "All seismic design shall fully comply with IS 1893" (referenced seismic spectra document EPCMD-1-ENGG-DBD-CS-002).
- Structural / maintenance provisions affecting nozzle loads (lifting / crane / pad info that may impose temporary loads):
  - EOT crane and lifting provisions list for maintenance (EOT, davits, lifting beams, hooks; EOT sizing based on maximum maintenance weight).
  - Piping / isolation requirements that affect nozzle boundary conditions (loads, restraints, flange/blanking):
    - Spectacle blinds / spade & spacer requirements at battery limits and isolation valves (size thresholds provided: spectacle blinds for lines connected to vessels: 8" and above for 150#; 6" and above for 300# and higher).
    - Isolation valves on inlet/outlet lines for exchanger maintenance; gate/butterfly requirements keyed to sizes and ratings.
  - Reinforcement / fabrication notes (implicit constraints referenced in vessel and exchanger sections):
    - Tube-to-tubesheet joint requirements for critical applications (expanded into 2 grooves and seal welded).
    - Corrosion allowances for static equipment and tubes (e.g., carbon steel static equipment CA 3 mm; tubes have specific min thicknesses).
  - Software and method expectation for nozzle/stress work:
  - Piping stress analysis shall use Caesar / NOZZLEPRO (explicitly listed under Software to be used).

#### Measurements Provided in Document

- Wind speeds (meteorology):
- Onshore: 50 m/s 3■second gust at 10 m elevation (50■yr return).
- Offshore operational: 15 m/s mean hourly at 10 m (5■yr).
- Offshore extreme survival: 33 m/s mean hourly at 10 m (500■yr).
- Flare heat radiation wind speed use: 11.5 m/s.
- Design and recorded temperatures:
- Maximum recorded dry bulb temperature: 48 °C.
- Minimum recorded dry bulb temperature: 3 °C.
- Design DBT for air coolers: 41 °C.

- Electrical design temperature outdoors: 43 °C.
- Design surface temperature (solar-exposed): 65 °C.
- Winterizing temperature: 10 °C.
- Low ambient design temperature: 7.5 °C.
- Rainfall / humidity / pressure:
- Maximum rainfall rate: 61 mm/h; 522 mm/24 hr.
- Relative humidity: max 92.8%, min

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